

# KWS-3 - very small angle scattering diffractometer with focusing mirror

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**Abstract:** KWS-3 is a very small angle neutron scattering (VSANS) instrument running on the focussing mirror principle.

## 1 Introduction

The principle of this instrument is a one-to-one image of an entrance aperture onto a 2D position sensitive detector by neutron reflection from a double-focussing toroidal mirror.

The instrument's standard configuration with a 9.5 m sample-to-detector distance allows performing scattering experiments with a wave vector transfer resolution between  $4.0 \cdot 10^{-5}$  and  $2.5 \cdot 10^{-3} \text{ \AA}^{-1}$ , bridging a gap between Bonse-Hart and pinhole cameras. A second sample position at 1.3 m sample-to-detector distance extends the Q-range of the instrument to  $2.0 \cdot 10^{-2} \text{ \AA}^{-1}$  and reaches more than one-decade overlapping with the classical pinhole SANS instruments. Another "mobile" sample position can be installed to adapt sophisticated sample environment between 8 and 2 m sample-to-detector distance according to the requested instrumental resolution.

The instrument covers the Q range of small angle light scattering instruments. Especially when samples are turbid due to multiple light scattering, V-SANS gives access to the structural investigation. Thus, the samples do not need to be diluted. The contrast variation method allows for highlighting of particular components.

Small-angle scattering is used for the analysis of structures with sizes just above the atomic scale, between 1 and about 100 nm, which can not be assessed or sufficiently characterised by microscopic techniques. KWS-3 is an important instrument extending the accessible range of scattering angles to very small angles with a superior neutron flux when compared to a conventional instrumental set up

with pinhole geometry. Thus, the length scale that can be analysed is extended beyond 10  $\mu\text{m}$  for numerous materials from physics, chemistry, materials science, and life science, such as alloys, diluted chemical solutions, and membrane systems.

## 2 Typical Applications

- High-flux bridge between Bonse-Hart and conventional SANS diffractometers
- Colloid science: mixtures of particles, particles of micron size, silicon macropore arrays
- Materials science: filled polymers, cements, microporous media
- Polymer science: constrained systems, emulsion polymerisation
- Bio science: aggregations of bio-molecules, protein complexes, crystallisation of proteins
- Hierarchical structures
- Multilamellar vesicles

## 3 Sample Environment

- Anton-Paar fluid rheometer
- Stopped flow cell
- Sample holders:
  - 4 horizontal x 2 vertical (temperature controlled) for standard Hellma cells 404-QX
  - 9 horizontal x 2 vertical (room temperature) for standard Hellma cells 404-QX
- Oil & water thermostats (typical 10 – 100 °C)
- Electric thermostat (RT - 200 °C)
- 6-positions thermostated (Peltier) sample holder (-40 – 150 °C)
- Magnet (2 T, vertical)
- Magnet (5 T, horizontal)
- Cryostat with sapphire windows
- High temperature furnace
- Pressure cells (500 bar, 2000 bar, 5000 bar)

## 4 Technical Data

### 4.1 Overall performance

- Resolution:  
 $\delta Q = 10^{-4} \text{ \AA}^{-1}$  (extension to  $4 \cdot 10^{-5} \text{ \AA}^{-1}$  possible)
- Q-range:  
 $1.0 \cdot 10^{-4} - 3 \cdot 10^{-3} \text{ \AA}^{-1}$  at 9.5 m distance  
 $1.5 \cdot 10^{-3} - 2 \cdot 10^{-2} \text{ \AA}^{-1}$  at 1.3 m distance
- Neutron flux:  
high-resolution mode:  $> 10000 \text{ n s}^{-1}$   
high-intensity mode:  $> 60000 \text{ n s}^{-1}$

### 4.2 Monochromator

- MgLi velocity selector
- Wavelength spread  $\Delta\lambda/\lambda = 0.2$
- Wavelength range  $\lambda = 10 - 30 \text{ \AA}$  (maximal flux at 12.8  $\text{\AA}$ )

### 4.3 Aperture sizes

- $1 \times 1 \text{ mm}^2 - 5 \times 5 \text{ mm}^2$

#### 4.4 Beam size at 9.5 m

- $0 \times 0 \text{ mm}^2 - 100 \times 25 \text{ mm}^2$

#### 4.5 Beam size at 1.3 m

- $0 \times 0 \text{ mm}^2 - 15 \times 10 \text{ mm}^2$



Figure 1: Instrument KWS-3 (Copyright by W. Schürmann, TUM).

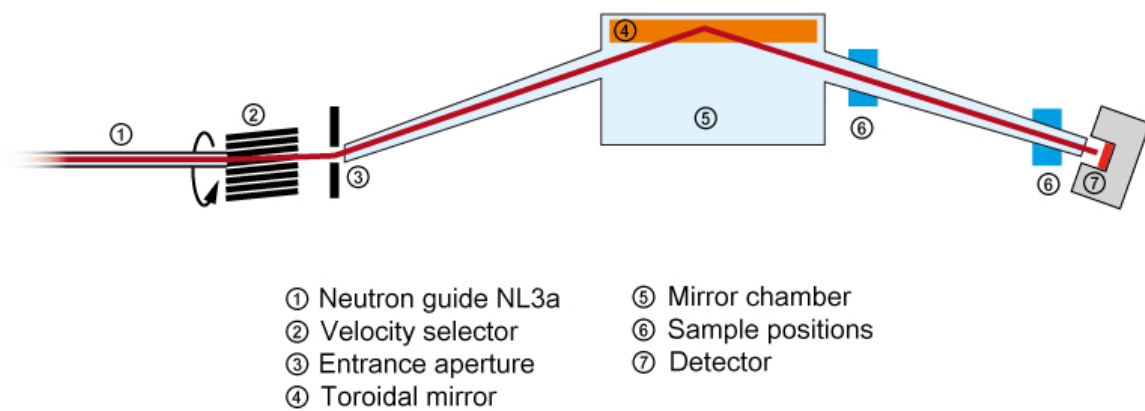


Figure 2: Schematic drawing of KWS-3.